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Shinozaki

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[54] RINGING CIRCUIT FOR USE IN PORTABLE TELEPHONE SET

[75] Inventor: Nobuhisa Shinozaki, Tokyo, Japan

[73] Assignee: NEC Corporation, Tokyo, Japan

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Related U.S. Application Data

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[30] Foreign Application Priority Data

Jan. 31, 1990 [JP] Japan 2-21233

[51] Int. Cl.[5] H04M 3/02

[52] U.S. Cl. 379/418; 379/388; 379/58; 379/419

[58] Field of Search 379/388, 418, 419, 58, 379/387, 390, 217, 423, 215, 61

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Primary Examiner—James L. Dwyer
Assistant Examiner—Paul A. Fournier
Attorney, Agent, or Firm—Sughrue, Mion, Zinn, Macpeak & Seas

[57] ABSTRACT

A portable telephone set having a ringing circuit for producing different ringing tones depending upon the use mode of the portable telephone set, a portable mode or a mobile mode. The ringing circuit comprises a mode detecting circuit for detecting the use mode, an internal loudspeaker housed in a housing of the portable telephone set for producing a first ringing signal when the portable telephone set is in the portable mode, an external loudspeaker connected externally of the housing for producing a second ringing signal when it is in the mobile mode and a ringing tone generator for generating a first and a second ringing tones for driving the respective loudspeakers producing first and second ringings. The first and second ringing tones have frequency spectra compatible with frequency characteristics of these loudspeakers to produce the respective ringings efficiently. The ringing signal generator may be a single ringing tone generating circuit producing two kinds of ringing tone or may be comprised of two different ringing tone generating circuits.

3 Claims, 5 Drawing Sheets

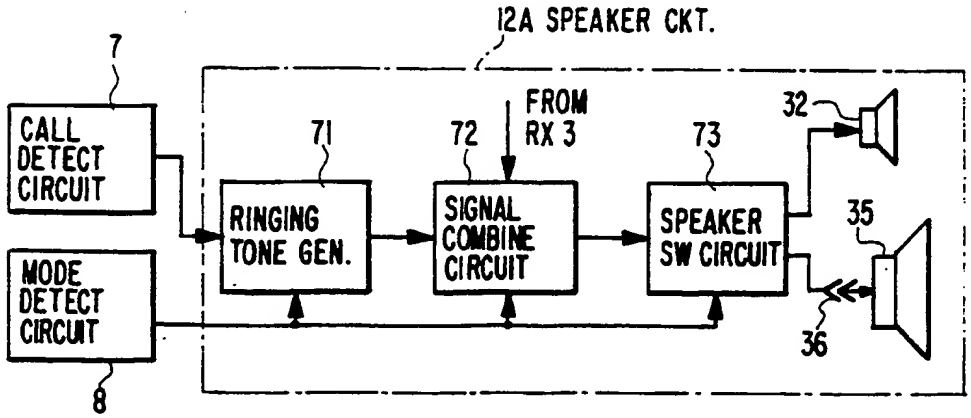


FIG. 1

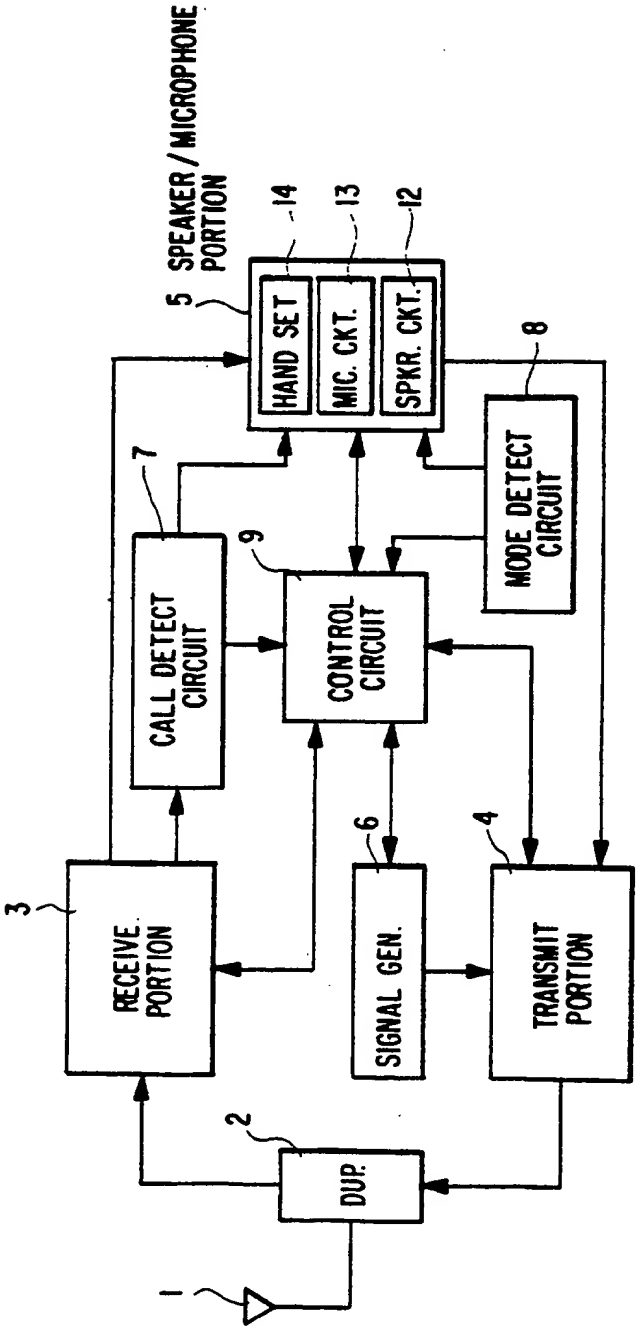

5 SPEAKER / MICROPHONE PORTION
14
13
12
HAND SET
MIC. CKT.
SPKR. CKT.
8
MODE DETECT CIRCUIT
7
9
CALL DETECT CIRCUIT
CONTROL CIRCUIT
6
4
3
RECEIVE PORTION
SIGNAL GEN.
TRANSMIT PORTION
2
DUP.
1

FIG. 2

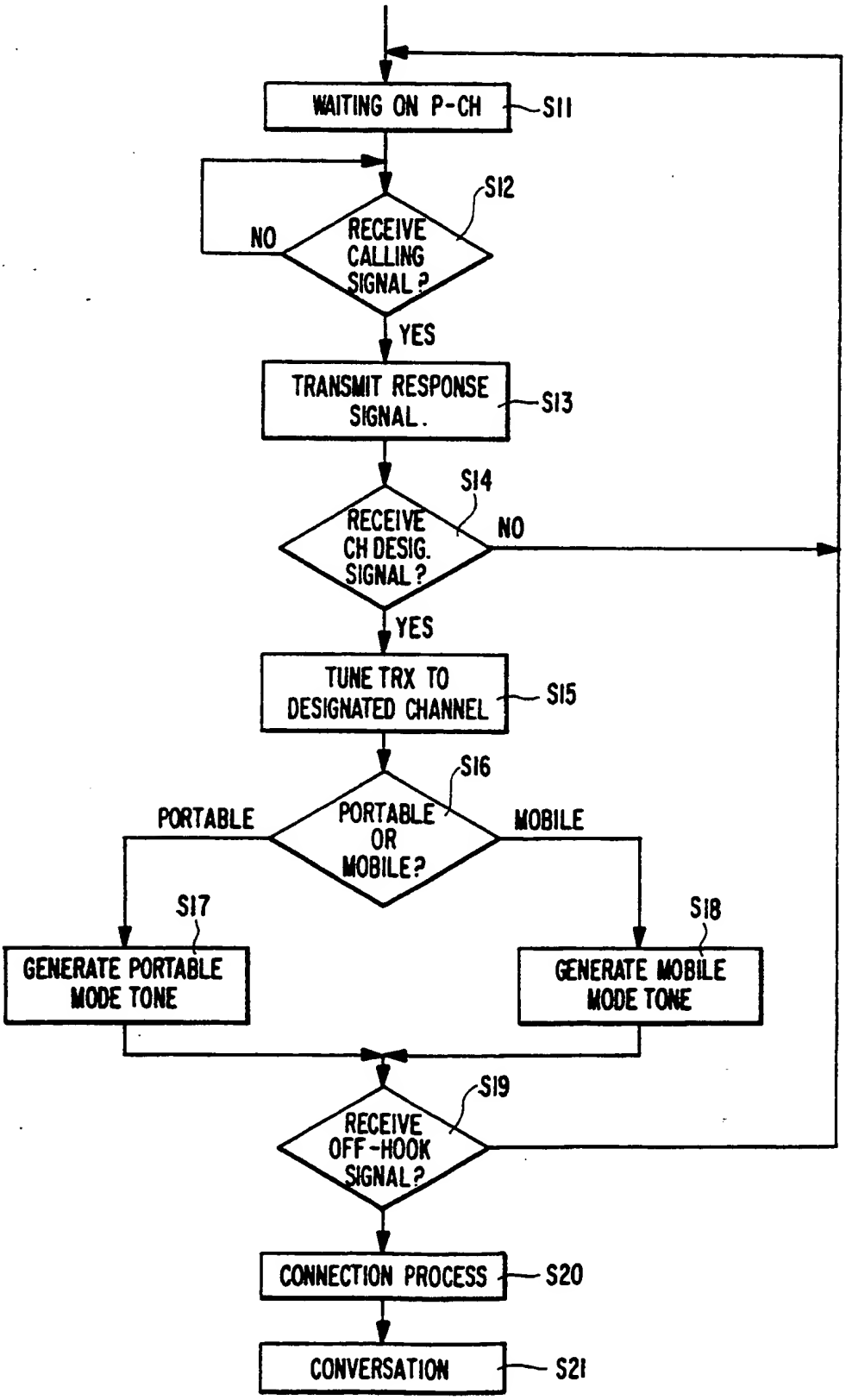

WAITING ON P-CH
S11
S12
RECEIVE CALLING SIGNAL?
NO
YES
TRANSMIT RESPONSE SIGNAL.
S13
S14
RECEIVE CH DESIG. SIGNAL?
NO
YES
TUNE TRX TO DESIGNATED CHANNEL
S15
S16
PORTABLE OR MOBILE?
PORTABLE
MOBILE
S17
S18
GENERATE PORTABLE MODE TONE
GENERATE MOBILE MODE TONE
S19
RECEIVE OFF-HOOK SIGNAL?
CONNECTION PROCESS
S20
CONVERSATION
S21

FIG. 3

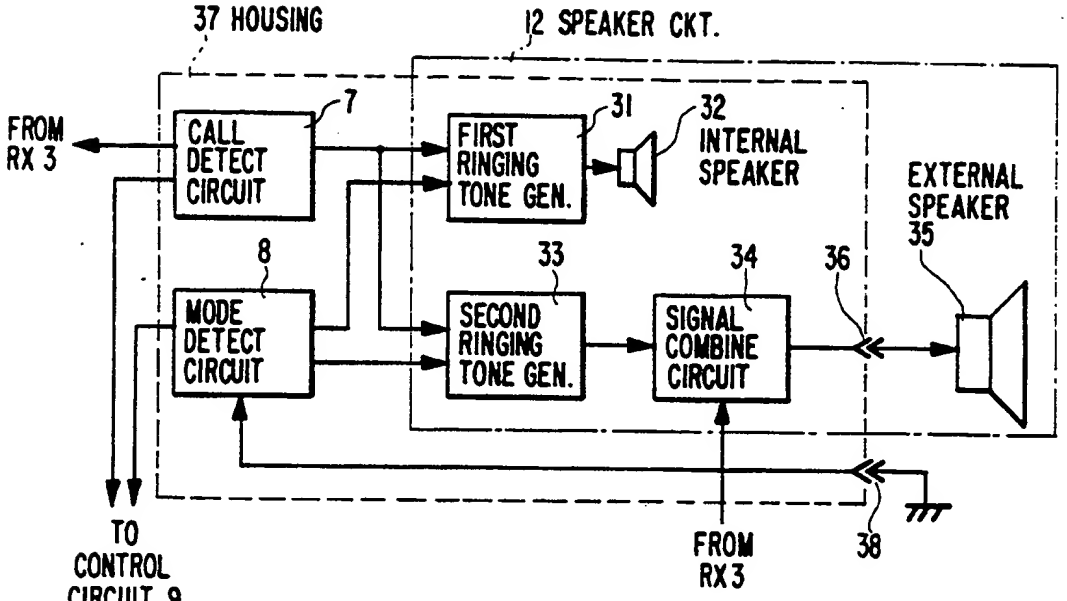


FIG. 5

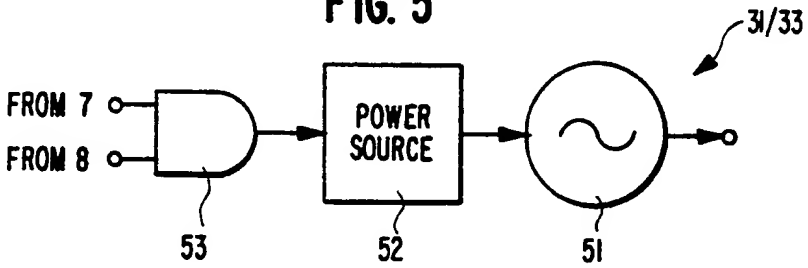
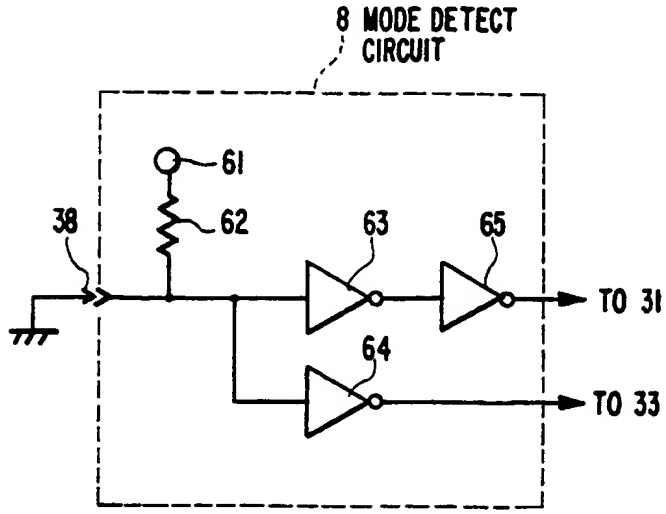


FIG. 6



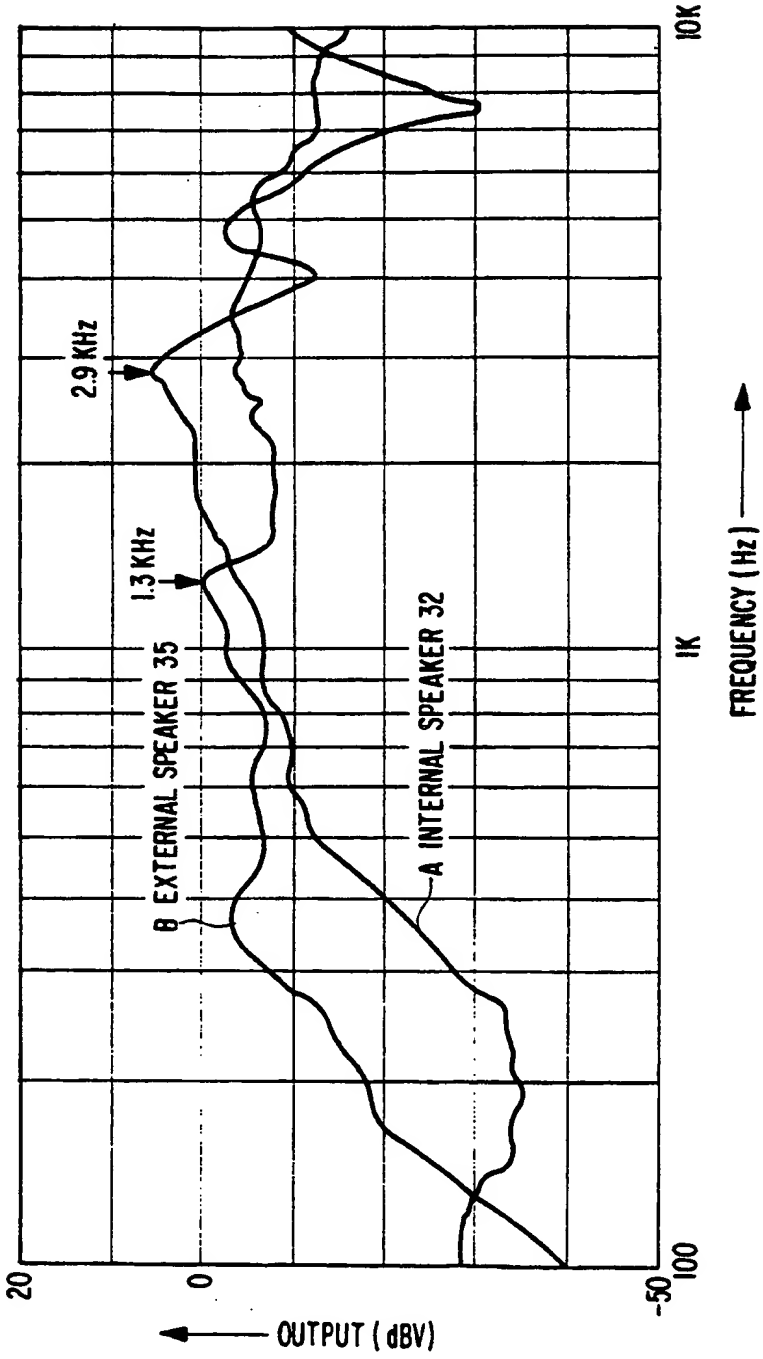

10K
2.9 KHz
1.3 KHz
1K
FREQUENCY (Hz)
B EXTERNAL SPEAKER 35
A INTERNAL SPEAKER 32
20
0
-50
100
OUTPUT (dBV)

FIG. 4

FIG. 7

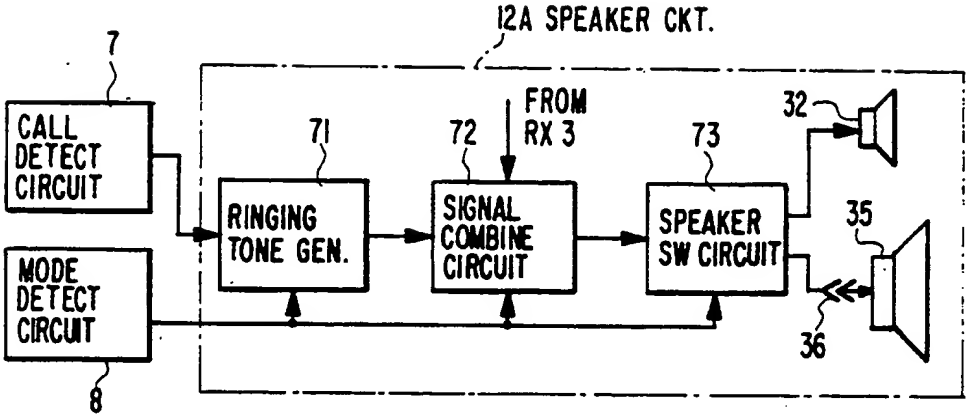
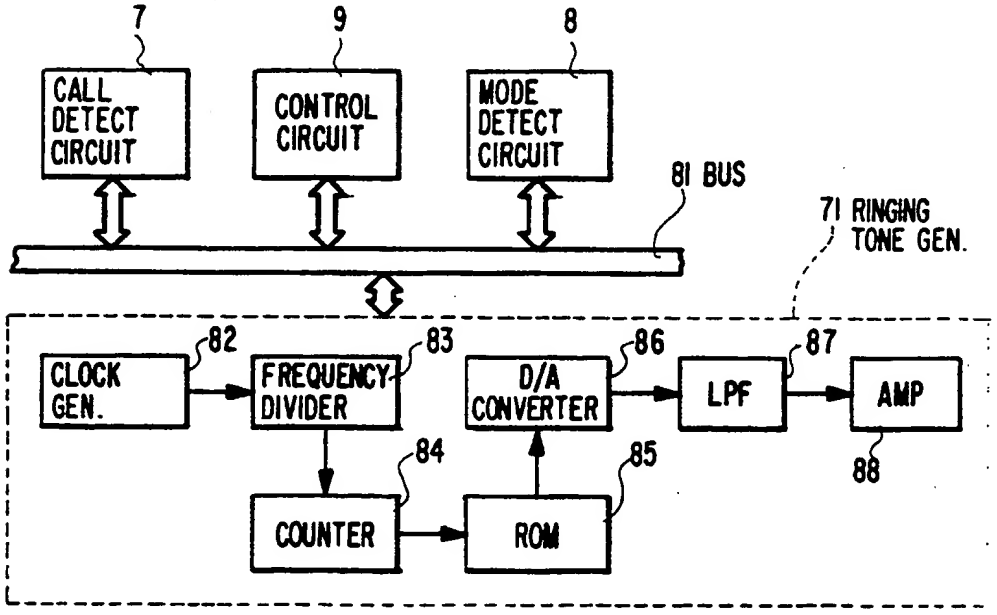

12A SPEAKER CKT.
7
CALL DETECT CIRCUIT
MODE DETECT CIRCUIT
8
71
RINGING TONE GEN.
72
FROM RX 3
SIGNAL COMBINE CIRCUIT
73
SPEAKER SW CIRCUIT
32
35
36

FIG. 8


7
CALL DETECT CIRCUIT
9
CONTROL CIRCUIT
8
MODE DETECT CIRCUIT
81 BUS
71 RINGING TONE GEN.
82
CLOCK GEN.
83
FREQUENCY DIVIDER
84
COUNTER
85
ROM
86
D/A CONVERTER
87
LPF
AMP
88

RINGING CIRCUIT FOR USE IN PORTABLE TELEPHONE SET

This is a divisional of Application No. 07/648,759 filed Jan. 31, 1991 now U.S. Pat. No. 5,303,284.

BACKGROUND OF THE INVENTION

The present invention relates to a portable telephone set and, more particularly, to a portable telephone set having a ringing circuit and to be used in a portable mode and mobile mode.

There has been known a portable telephone set which has two use-modes, i.e., a portable mode in which the telephone set is used by a user while bringing it with him and a mobile mode in which it is mounted on a vehicle. In the portable mode, a compact and light-weight, built-in loudspeaker is used. In the mobile mode, a relatively large external loudspeaker is used because the loudspeaker outputs not only a ringing tone but also a voice signal and thus the voice quality therefrom plays an important role.

In general, in the above-mentioned ringing circuit, the built-in, i.e., internal loudspeaker is compact and has narrow frequency characteristics while the external loudspeaker has relatively wide frequency characteristics. In the conventional ringing circuit, however, a ringing signal having a single frequency spectrum is used. Thus, when the frequency characteristics of the internal and external loudspeakers are different, there may be a problem that the energy of a ringing signal for driving the loudspeaker cannot be used effectively. More definitely, when the ringing signal spectrum is broad and the internal loudspeaker is used, a portion of the frequency spectrum of the ringing signal which is not used increases and the power consumption of a ringing signal generating circuit is undesirably increased. On the other hand, when the ringing signal frequency spectrum is narrowed to adjust it to the internal loudspeaker, it is impossible to supply enough power to the external loudspeaker, so that an effective ringing sound cannot be generated.

Furthermore, the switching between the internal and external loudspeakers is manually carried out. This manual switching is a troublesome operation for the user.

SUMMARY OF THE INVENTION

An object of the present invention is, therefore, to provide a ringing circuit for use in a portable telephone set which circuit is capable of producing an effective ringing sound for either an internal or external loudspeaker thereof to be used.

Another object of the present invention is to provide a ringing circuit for use in a portable telephone set which circuit automatically switches internal and external loudspeakers based on the use conditions of the portable telephone set.

According to the present invention, there is provided a portable telephone set having two use-modes, portable mode and mobile mode, and includes a mode detecting circuit for detecting the use-modes. Upon a call from a base station, a ringing circuit of the portable telephone set generates a ringing sound from an internal loudspeaker thereof when the portable mode is detected or from an external loudspeaker when the mobile mode is detected. In the portable mode, the ringing circuit produces a first ringing signal having a frequency spectrum adjusted to frequency characteristics of the internal loudspeaker and, in the mobile mode, produces a second ringing signal having a frequency spectrum adjusted to frequency characteristics of the external loudspeaker. The ringing circuit may include two ringing signal generating circuits which generate the first and second ringing signals, respectively. Further, the ringing circuit may include a single ringing signal generating circuit which generates the first or second ringing signal depending upon the use-mode detected. When the external loudspeaker is connected to the telephone set, an input terminal of the mode detecting circuit is grounded simultaneously and this grounding signal can be used as the detection signal of the mode detection circuit.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other objects, features and advantages of this invention will become more apparent by reference to the following detailed description of the invention taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a schematic block diagram showing a portable telephone set according to an embodiment of the present invention;

FIG. 2 is a flowchart explaining the call reception operation of the FIG. 1 portable telephone set;

FIG. 3 is a schematic block diagram showing a specific construction of the speaker/microphone of the FIG. 1 embodiment;

FIG. 4 shows frequency characteristics of an internal loudspeaker and an external loudspeaker which are used in the FIG. 3 embodiment;

FIG. 5 is a schematic block diagram showing a ringing tone generator of the speaker/microphone portion shown in FIG. 3;

FIG. 6 is a schematic block diagram showing a mode detecting circuit used in the FIG. 3 embodiment;

FIG. 7 is a schematic block diagram showing another specific construction of speaker/microphone portion of the FIG. 1 embodiment; and

FIG. 8 is a schematic block diagram showing a ringing tone generator of the speaker/microphone portion shown in FIG. 7.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1, a portable telephone set 10 can be carried by the user or mounted on a vehicle. The telephone set 10 has an antenna 1 picking up a radio frequency (RF) signal and radiating an RF signal. The antenna 1 may be replaced by or switched to a vehicle-mounted antenna when the telephone set 10 is mounted on the vehicle. The picked-up RF signal is supplied to a receiver portion 3 through an antenna duplexer 2. The receiver portion 3 demodulates the received RF signal to produce an audio frequency (AF) signal which may include a voice signal and a data signal. The voice signal is supplied to a speaker/microphone portion 5 to be outputted from a speaker circuit 12 or a handset 14 therewithin. The handset 14 may include an earpiece receiver and a mouthpiece microphone. The data signal is supplied to both a call detector circuit 7 and a control circuit 9.

The speaker/microphone portion 5 includes a microphone circuit 13 as well as the speaker circuit 12 and the handset 14. The microphone circuit 13 and speaker circuit 12 are used for the so-called hands-free telephon-

ing in which the user can make conversation through these circuits 12 and 13 without resorting to the handset 14. The hands-free telephoning can be performed only when the telephone set 10 is mounted on a vehicle. In this case, the speaker circuit 12 is used for conversation and for generating an audible ringing tone. When the telephone set 10 is used as a portable one, the handset 14 is used for conversation and the speaker circuit 12 is dedicated to generating an audible ringing tone.

A voice signal is inputted through the microphone circuit 13 or the handset 14 and supplied to a transmitter portion 4. The transmitter portion 4 is also supplied with a data signal from the control circuit 9 and various signals from a signal generator 6. The transmitter portion 4 transmits the supplied signals to a base station (not shown) of a mobile communications system through the duplexer 2 and the antenna 1. The signal generator 6 generates the various signals under the control of control circuit 9. The control circuit 9 also controls the receiver and transmitter portions 3 and 4, especially to cause them to tune to a desired radio frequency channel in a well-known manner.

The call detector circuit 7 detects from the supplied data signal a calling signal addressed to the telephone set 10 and produces a call detection signal. The call detection signal is led to both the control circuit 9 and speaker/microphone circuit 5. In response, the speaker/microphone circuit 5 generates an audible ringing tone through the speaker circuit 12 to alert the user to a call.

The telephone set 10 further includes a mode detect circuit 8 which detects the use condition of the telephone set 10. More specifically, if the telephone set 10 is used as a portable set, the mode detect circuit 8 produces a portable-mode signal. If the telephone set 10 is mounted on a vehicle, the mode detect circuit 8 produces a mobile-mode signal. Upon the mobile-mode signal, the control circuit 9 may switch from the antenna 1 to the vehicle-mounted antenna.

In response to the portable-mode signal, the speaker circuit 12 generates a first audible ringing tone whose frequency is suitable to an internal speaker accommodated in the telephone set 10, which will be described later. On the other hand, in response to the mobile-mode signal, the speaker circuit 12 generates a second audible ringing tone whose frequency is suitable to an external speaker to be connected to the telephone set 10, which will also be described later. Since the frequencies of the ringing tones are so selected, it is possible to produce an audible ringing tone at the maximum level with the minimum power consumption.

In FIG. 2, the portable telephone set 10 waits at step S11 for a call coming through a so-called paging channel which is one of control channels for broadcasting calling signals and various control signals from a base station to portable or mobile telephone sets. If the telephone set 10 receives a calling signal addressed thereto at step S12 and detects it with the call detect circuit 7, the control circuit 9 causes the signal generator 6 to generate a response signal. The control circuit 9 further causes the transmitter portion 4 to transmit at step S13 the response signal to the base station. Thereafter, the control circuit 9 checks at step S14 if it receives a channel designate signal indicating a designated speech channel. If the control circuit 9 does not receive the channel designate signal within a predetermined period of time, the operation returns to step S11. Otherwise, the control circuit 9 causes the receiver and transmitter portions 3, 4 to tune to the designated speech channel at step S15.

Step S15 is followed by step S16 at which the use condition of telephone set 10 is checked using the mode detect circuit 8. If the set 10 is used as a portable set, the speaker circuit 12 generates a portable-mode ringing tone whose frequency is suitable to the internal loudspeaker at step S17. When the set 10 is mounted on a vehicle, i.e., used as a mobile set, the speaker circuit 12 generates a mobile-mode ringing tone whose frequency is suitable to the external loudspeaker at step S18. Steps S17 and S18 are followed by step S19 at which the control circuit 9 monitors if it receives an off-hook signal indicating that the user goes off-hook to start a telephone conversation. If the off-hook signal is not received within a predetermined period of time, the telephone set 10 returns to the waiting state (step S11).

If the off-hook signal is received at step S19, the control circuit 9 performs at step S20 a connection process in which the handset 14 is connected to the receiver and transmitter portions 3, 4 in the portable mode while the microphone circuit 13 and the speaker circuit 12 are connected to the transmitter and receiver portions 4 and 3, respectively, in the mobile mode. The completion of the connection process allows the user to start a telephone conversation at step S21.

In FIG. 3, the speaker circuit 12 included in the speaker/microphone portion 5 comprises a first ringing tone generator 31 for generating a first ringing tone whose frequency is suitable to an internal loudspeaker 32 connected thereto. The speaker circuit 12 also comprises a second ringing tone generator 33 for generating a second ringing tone whose frequency is suitable to an external loudspeaker 35. Between the second ringing tone generator 33 and the external loudspeaker 35 is connected a signal combining circuit 34 for combining the second ringing tone and a voice signal from the receiver 3 (FIG. 1). The external loudspeaker 35 is to be connected to the signal combining circuit 34 through a terminal 36 attached on a telephone set housing 37. While a voice signal is outputted through the external speaker 35 together with the ringing tone in the mobile mode, a voice signal is outputted through the handset 14 (FIG. 1) in the portable mode. In the portable mode, only the ringing tone is outputted from the internal loudspeaker 32.

As mentioned above, the frequency spectrum of the first ringing signal produced by the first ringing tone generator 31 is set so that it substantially corresponds to a relatively narrow frequency characteristics of the internal loudspeaker 32. On the other hand, the frequency spectrum of the second ringing signal generated by the second ringing tone generator 33 is set so that it substantially corresponds to a relatively wide frequency characteristics of the external loudspeaker 35.

A connector 38 mounted on the housing 37 is connected to the mode detecting circuit 8. The connector 38 is grounded when the telephone set, i.e., the housing 37 is mounted on a vehicle. Thus, when the connector 38 is not grounded, the mode detecting circuit 8 detects that the telephone set is in the portable mode while when the connector 38 is grounded, the mode detecting circuit 8 indicates that the telephone set is in the mobile mode. The connector 38 may be constructed such that, when the external loudspeaker 35 is connected through the connector 36 to the signal combining circuit 34, it is grounded simultaneously. The mode detecting circuit 8 provides a portable mode signal indicative of the porta-

ble mode to the first ringing tone generator 31 and a mobile mode signal indicative of the mobile mode to the second ringing signal generator 33. The call detecting circuit 7 detects a calling signal from a data signal from the receiving portion 3 and provides a call detection signal indicative of the presence of calling signal reception to both the ringing tone generators 31 and 33.

With the FIG. 3 construction, when the telephone set is in the portable mode and there is a calling signal reception, the first ringing tone generator 31 is operated to send the first ringing signal to the internal loudspeaker 32. In this case, since the frequency spectrum of the first ringing signal corresponds to the frequency characteristics of the internal loudspeaker 32, the first ringing tone generator 31 can operate the internal loudspeaker 32 effectively with minimum power and thus the ringing can be performed effectively. On the other hand, when the telephone set is in the mobile mode and there is a calling signal reception, the second ringing tone generator 33 operates to produce the second ringing signal to the external loudspeaker 35. In this case, since the frequency spectrum of the second ringing signal corresponds to the frequency characteristics of the external loudspeaker 35, the second ringing tone generator 33 actuates the external loudspeaker 35 with full power, so that it is possible to call with maximum volume of the external loudspeaker 35.

Referring to FIG. 4, an example of frequency characteristics of the internal loudspeaker 32 is shown by a curve A and that of the external loudspeaker 35 is shown by a curve B. These data were obtained based on the output voltages of a microphone circuit which picks up sound from the respective loudspeakers under the same measuring conditions. In general, the internal loudspeaker 32 is compact and thus its sound generating efficiency is better in a narrow frequency band. On the other hand, the external loudspeaker 35 does not provide high sound generating efficiency although it exhibits a good frequency characteristics. The curve A indicates that the internal loudspeaker has a sharp peak at 2.9 kHz with its output level being about 5.2 dBV. The curve A also shows that the internal loudspeaker outputs an output level of about −1.5 dBV at 1.5 kHz and of about −3.5 dBV at 1.3 kHz. On the other hand, the curve B exhibits that the external loudspeaker has a relatively wide frequency characteristics and its maximum output point is at 1.3 kHz with level being about 0 dBV. Also, the external loudspeaker outputs an output level of about −7.0 dBV at 1.5 kHz and of −4.0 dBV at 2.9 kHz.

Setting the ringing signal frequency to a single frequency such as 1.5 kHz which is the frequency of ringer of a cable telephone, there is no problem for the external loudspeaker 35 since its frequency at which a high output level is produced is substantially coincident with the ringer frequency. However, for the internal loudspeaker 32, its output level at the ringer frequency is lower than the maximum output level by about 7 dB. When such internal and external loudspeakers 32 and 35 are driven by a ringing tone having such a single frequency, it is impossible to operate the loudspeaker and the ringing tone generator efficiently in either the portable mode or the mobile mode. However, when, as shown in FIG. 4, the frequencies of the first and second ringing tones respectively generated by the ringing tone generators 31 and 33 are set at around 2.9 kHz and around 1.3 kHz, respectively, it is possible to use the loudspeakers 32 and 35 and the ringing tone generators 31 and 33 efficiently. Moreover, each of the first and second ringing tones need not have wide frequency spectra and thus they can use a tone having a single frequency spectrum.

In FIG. 5, each of the ringing tone generators 31 and 33 comprises an oscillator 51 for producing a ringing tone, an oscillator power source 52 for supplying power from a power source to the oscillator 51 and for on-off operating the power source and an AND gate 53 for on-off controlling the oscillator power source 52. To one input of AND gate 53 a calling signal detection signal is supplied from the calling signal detection circuit 7 and to the other input thereof a portable mode or mobile mode signal is supplied from the mode detecting circuit 8. When AND gate 53 receives these inputs, the gate 53 makes the oscillator power source 52 turn on so that the oscillator 51 produces the first or second ringing tone. More specifically, in the first ringing tone generator 31, AND gate 53 makes the power source 52 turn on when the gate 53 receives the calling signal detection signal and the portable mode signal. In the second ringing tone generator 33, AND gate 53 makes the power source 52 turn on when the gate 53 receives the calling signal detection signal and the mobile mode signal.

In FIG. 6, the mode detecting circuit 8 comprises a terminal 61 to which a positive voltage is applied. To the terminal 61 is connected the one end of a pull-up resister 62 the other end of which is connected to the connector 38. To the connector 38 are connected the inputs of inverters 63 and 64. The output of inverter 63 is connected to the input of an inverter 65 whose output is connected to the first ringing tone generator 31. The output of inverter 64 is connected to the second ringing tone generator 33.

In operation, when the connector 38 is grounded, i.e., the telephone set is mounted on a vehicle, the output of inverter 64 becomes a high level indicative of the mobile mode, while the output of inverter 65 becomes a low level. Thus, only the second ringing tone generator 33 is enabled to generate the second ringing tone. In contrast, when the connector 38 is not grounded, i.e., the telephone set is removed from a vehicle, the output of the inverter 65 becomes a high level indicative of the portable mode, while the output of inverter 64 becomes a low level. Thus, only the first ringing tone generator 31 is enabled to generate the first ringing tone.

FIG. 7 shows another example of the speaker circuit, denoted by reference numeral 12A, comprising a ringing tone generator 71 which produces the first or second ringing tone according to the use mode of the telephone set. The output of tone generator 71 is supplied to a signal combining circuit 72 to be combined with a voice signal from the receiving portion 3. The output of combining circuit 72 is coupled to a speaker switching circuit 73 which connects the output of signal combining circuit 72 to one of the internal and external loudspeakers 32 and 35. The external loudspeaker 35 is to be connected to the speaker switching circuit 73 through the connector 36.

Although the use mode signal outputted by the mode detecting circuit 8 may include the portable mode signal and the mobile mode signal as described with reference to FIG. 6, here, an output level variation of either of the mode signals is utilized. The ringing tone generator 71 produces the first ringing tone when the use mode signal is the portable mode signal and the calling signal detection signal is supplied. The generator 71 also gen-

erates the second ringing tone when the use mode signal is the mobile mode signal and the calling signal detection signal is supplied. The signal combining circuit **72** combines the voice signal and the second ringing tone when the use mode signal is the mobile mode signal while it merely passes therethrough the first ringing tone when the use mode signal is the portable mode signal. The output terminal of the speaker switching circuit **73** is switched to the internal loudspeaker **32** when the use mode is the portable mode and to the external loudspeaker **35** when it is the mobile mode. Therefore, the ringing tone generator **71** of the speaker circuit **12** produces two kinds of ringing tones.

In FIG. **8**, the ringing tone generator **71** is connected through a bus **81** to the control circuit **9**, which may comprise a microprocessor, the calling signal detection circuit **7** and the mode detecting circuit **8**. The ringing tone generator **71** comprises a clock generator **82** for generating a clock signal. The clock signal is supplied to a frequency divider **83** at which the clock signal is frequency divided. The divided clock signal is counted by a counter **84** whose output is applied to a read-only memory (ROM) **85**. ROM **85** preliminarily stores patterns corresponding to the first and second ringing tone frequencies and provides one of the stored patterns according to the output of counter **84**. The output pattern of ROM **85** is supplied to a D/A converter **86** which converts the supplied patterns into a sinusoidal wave signal containing high harmonics. A low-pass filter (LPF) **87** eliminates the high harmonics contained in the output of D/A converter **86** to provide a basic sinusoidal wave signal and an amplifier **88** amplifies the basic sinusoidal wave signal.

The frequency divider **83** divides the frequency of the clock signal by a first frequency-dividing ratio when the portable mode signal is supplied from the mode detecting circuit **8** and the calling signal detection signal is supplied from the signal receive detecting circuit **7**. On the other hand, when the mobile mode signal and the calling signal detection signal are supplied, the frequency divider **83** divides the clock signal by a second frequency-dividing ratio. The counter **84** is used as a decoder for assigning addresses for ROM **85** and the output of counter **84** when counted with the first frequency-dividing ratio reads the pattern corresponding to the first ringing tone frequency stored in ROM **85**. On the other hand, the output of counter **84** when counted with the second frequency-dividing ratio reads the pattern corresponding to the second ringing tone frequency stored in ROM **85**. In this manner, the two kinds of ringing tones can be digitally produced.

As described hereinbefore, the ringing circuit of the portable telephone set according to the present invention includes the ringing tone generators for generating the first and second ringing tones whose frequencies are set to be suitable to frequency characteristics of the internal loudspeaker to be used in the portable mode and of the external loudspeaker to be used in the mobile mode, respectively. The ringing tone is selected according to the use mode of the telephone set in which the associated loudspeaker is actuated. Therefore, it is possible to utilize the ringing tone effectively in either mode and to provide maximum ringing with minimum power consumption.

What is claimed is:

1. A telephone set comprising:

means for detecting a calling signal for said telephone set to produce a calling detection signal;

means for detecting whether said telephone set is in a portable mode or mobile mode and producing first and second mode signals when said telephone set is in said portable mode and said mobile mode, respectively;

generator means for generating a first ringing signal having a first frequency characteristic in response to said calling detection signal and to said first mode signal and generating a second ringing signal having a second frequency characteristic different from said first frequency characteristic in response to said calling detection signal and to said second mode signal; and

switch means for providing said first ringing signal to an internal loudspeaker having a frequency characteristic corresponding to said first frequency characteristic in response to said first mode signal and providing said second ringing signal to an external loudspeaker having a frequency characteristic corresponding to said second frequency characteristic in response to said second mode signal.

2. A telephone set as claimed in claim **1**, further comprising means connected between said generator means and said switch means for combining said second ringing signal and a voice signal in response to said second mode signal and passing therethrough said first ringing signal in response to said first mode signal.

3. A telephone set as claimed in claim **1**, wherein said generator means comprises:

a clock generator for generating a clock signal;

a frequency divider for frequency dividing said clock signal based on said first and second mode signal to produce first and second divided signals, respectively;

means for storing first and second patterns respectively corresponding to the frequency characteristics of said first and second loudspeakers, and producing the stored first and second patterns in response to said first and second mode signals, respectively; and

means for converting the produced first and second patterns into first and second converted signals, respectively, and providing said first and second converted signals to said switch means as said first and second ringing signals, respectively.

* * * * *